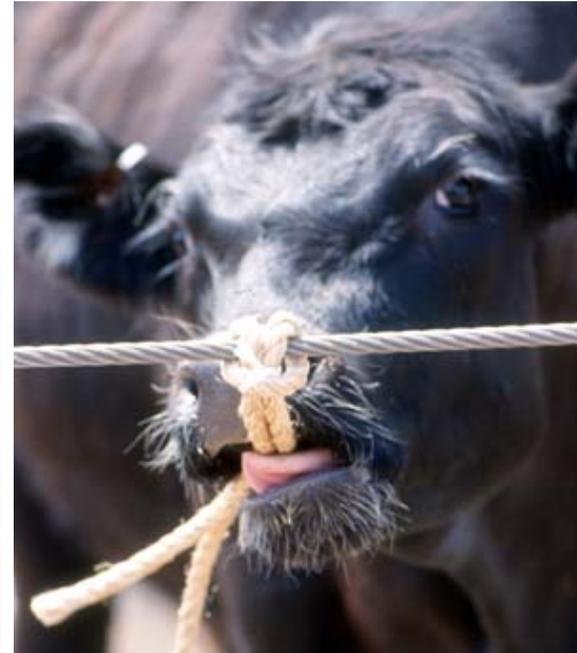


Intervention strategies to reduce *Escherichia coli* O157:H7 in beef feedyards

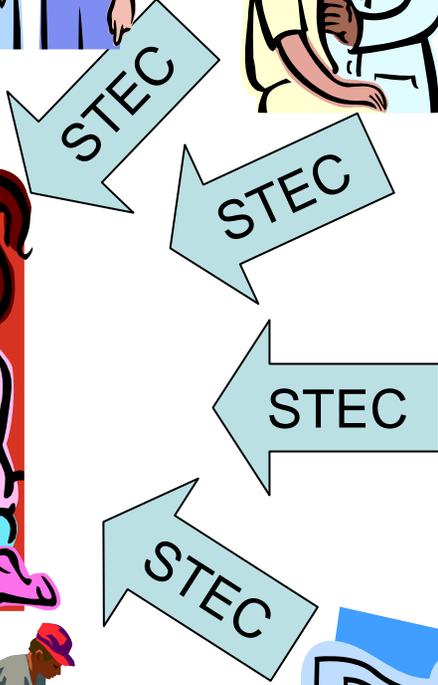
D. R. Smith, R. A. Moxley, T. J. Klopfenstein, G. E. Erickson

UNIVERSITY OF
Nebraska
Lincoln





FOOD and WATER



Animal Environments

MEAT & POULTRY

The business journal of the meat and poultry industry

FEBRUARY 2003

\$2.7 Billion

The cost of
E. coli O157:H7

Newsweek

September 1, 2007 \$2.00

Can This Meat Kill You?

THE E. COLI THREAT—IT'S WORSE THAN YOU THINK

SWINGING MOSCOW
WOMEN'S B-BALL ON THE LINE

BEef CHICK GROUND (FAMILY PACK)
SAFE HANDLING INSTRUCTIONS
DO NOT TOUCH THE MEAT. DO NOT TOUCH THE JUICES.
DO NOT TOUCH THE MEAT OR JUICES TO YOUR FACE, HANDS, OR OTHER PARTS OF YOUR BODY.
DO NOT FEED MEAT TO PETS.
DO NOT FEED MEAT TO OTHER ANIMALS.
DO NOT FEED MEAT TO BIRDS.
DO NOT FEED MEAT TO SWINE.
DO NOT FEED MEAT TO CATTLE.
DO NOT FEED MEAT TO SHEEP.
DO NOT FEED MEAT TO GOATS.
DO NOT FEED MEAT TO HORSES.
DO NOT FEED MEAT TO PIGS.
DO NOT FEED MEAT TO BIRDS.
DO NOT FEED MEAT TO OTHER ANIMALS.
DO NOT FEED MEAT TO BIRDS.
DO NOT FEED MEAT TO OTHER ANIMALS.
DO NOT FEED MEAT TO BIRDS.
DO NOT FEED MEAT TO OTHER ANIMALS.

USE BY AUG 26

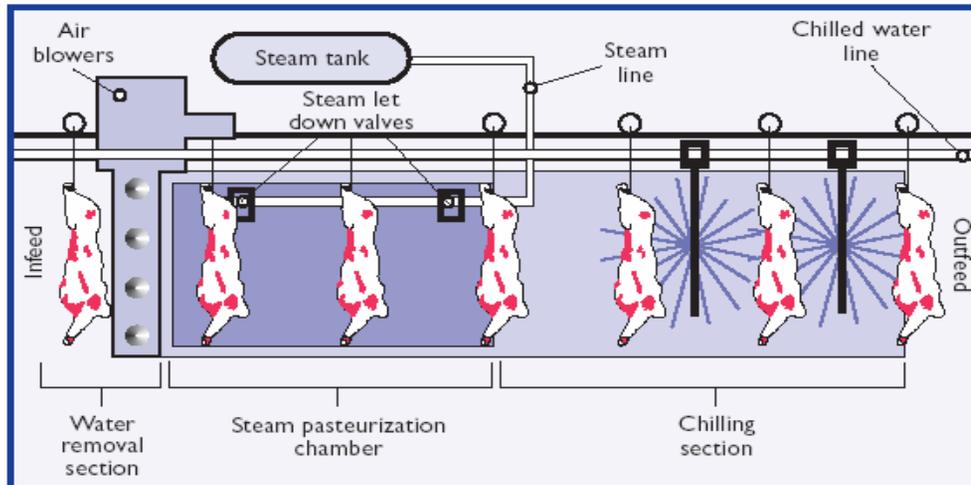
1.99 \$3.28

Beef industry interventions

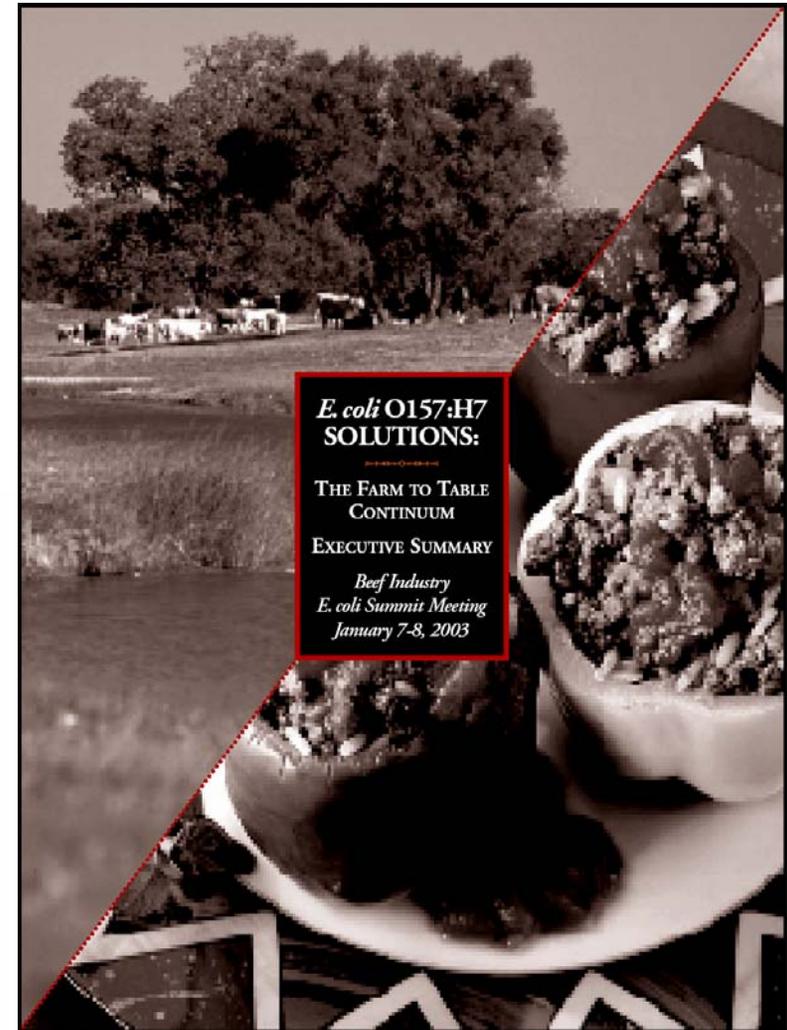
Post-harvest

- Carcass washes
- Steam pasteurization
- Test and hold

Figure C-3
Beef Steam Pasteurization System — Static Chamber Unit



Source: Frigoscandia Equipment



Good News:

There is less
probability to
detect *E. coli*
O157:H7 in
ground beef



News & Events

News Releases

FSIS Ground Beef Sampling Shows Substantial *E. coli* O157:H7 Decline In 2004

.....

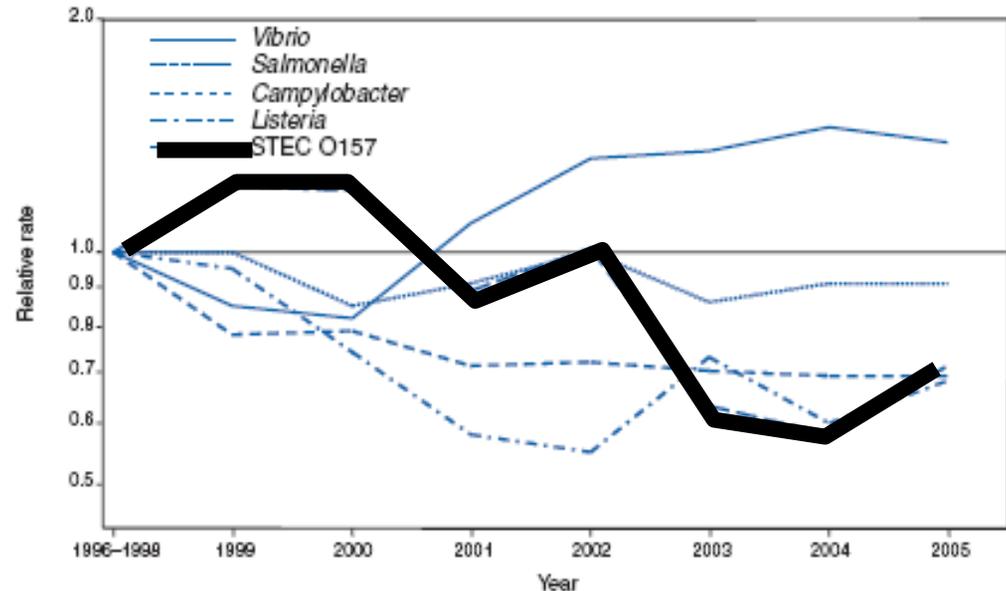
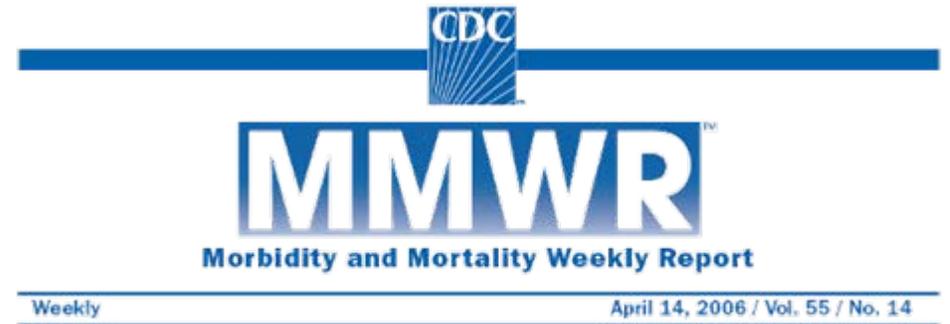
Congressional and Public Affairs
(202) 720-9113
Steven Cohen

WASHINGTON, Feb. 28, 2005 - The U.S. Department of Agriculture's Food Safety and Inspection Service today released data showing a 43.3% drop in the percentage of *E. coli* O157:H7 positive ground beef regulatory samples collected in 2004 compared with the previous year.

Human illness due to *E. coli* O157:H7 has decreased

“The declines in the incidence of STEC O157 infections observed in recent years suggest that coordinated efforts by regulators and industry have been effective in reducing contamination and illness related to ground beef”

MMWR April 14, 2006. 55(14)

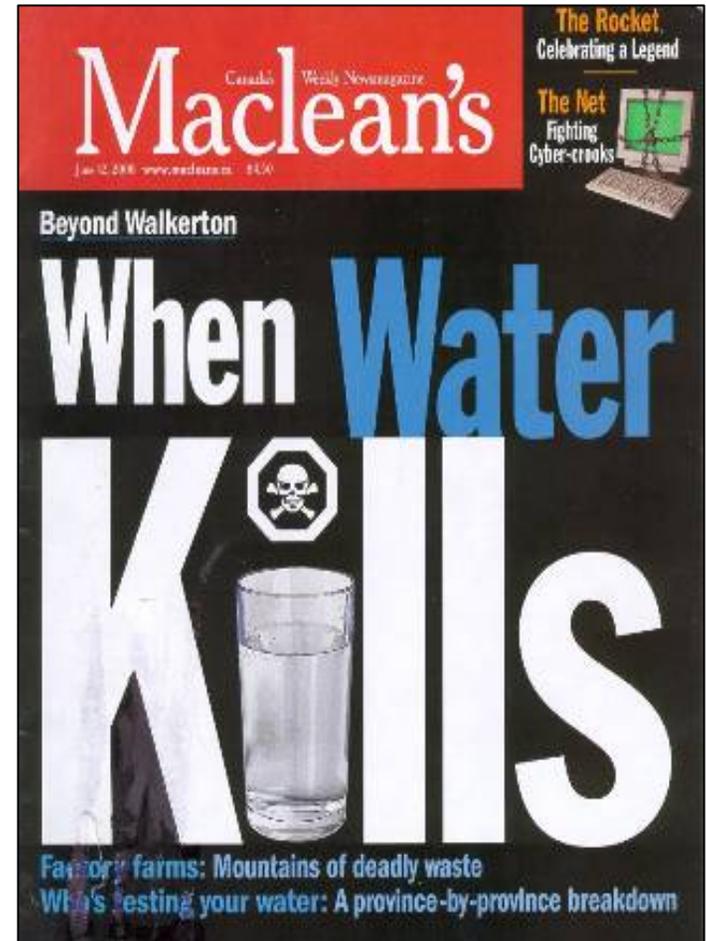


STEC O157 2005: 1.06 / 100,000

2010 goal: 1.00 / 100,000

<http://www.healthypeople.gov/document/html/volume1/10food.htm>

Live cattle populations are a major reservoir of *E. coli* O157:H7



Live cattle populations are a major reservoir of *E. coli* O157:H7

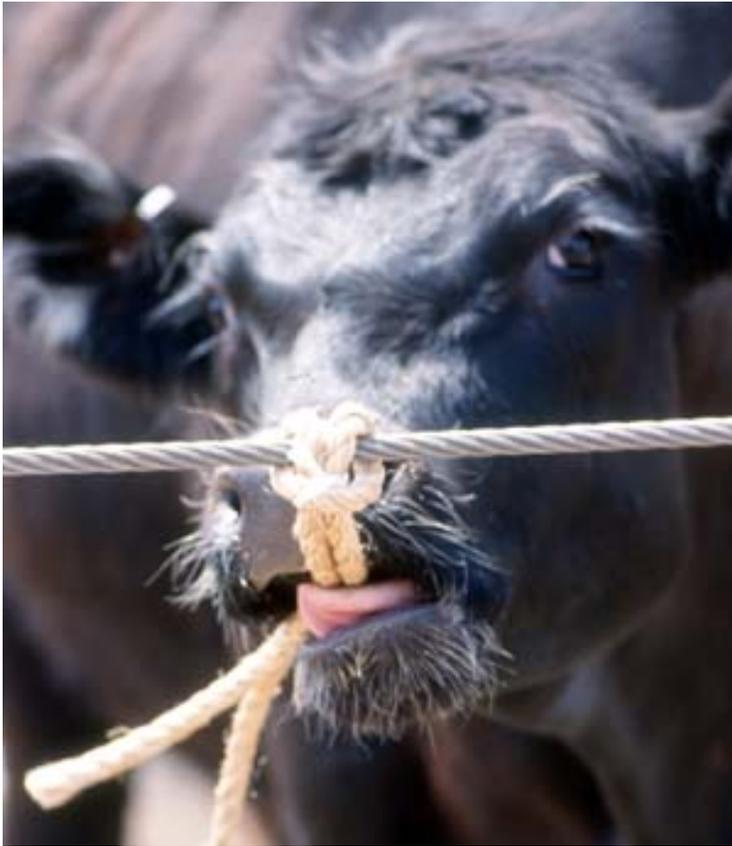
What affects the probability for cattle to shed the organism?

What can we do about it?

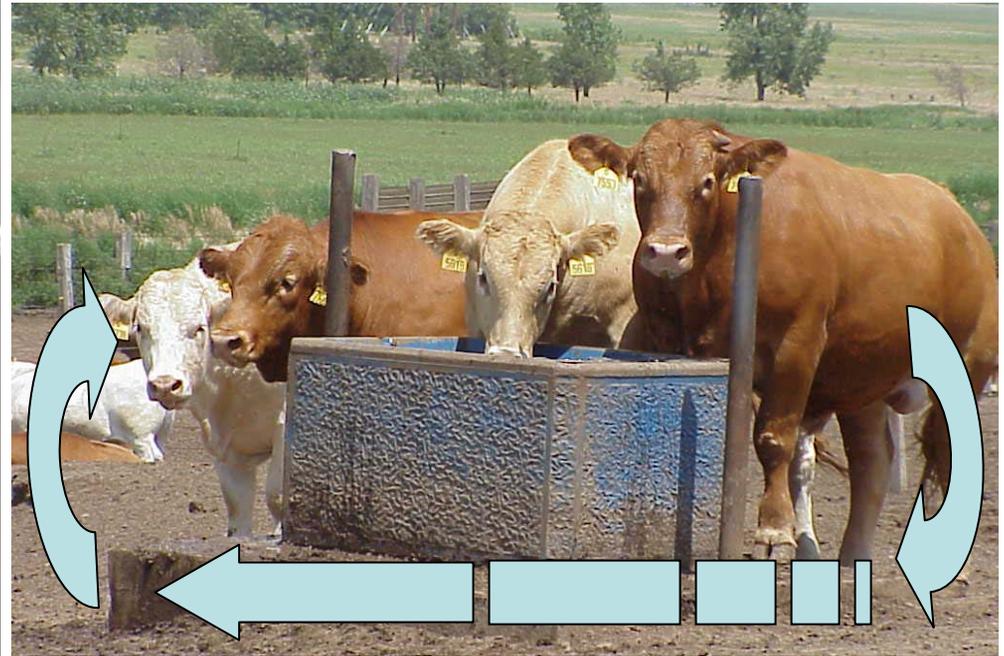


Q: What affects the probability for cattle to shed *E. coli* O157:H7?

A: The natural ecology of *E. coli*



Smith et al. Foodborne Pathogens and Disease. March, 2005, Vol 2(1): 50-60



What can we do about it?

*Prevalence ~ rate of exposure * duration of infection*

Strategies for intervention:

Limiting exposure

Reducing the duration of infection (colonization)



**Vaccination as a strategy to
reduce shedding of *E. coli*
O157:H7 in cattle
populations**

Stimulate immunity
against type III
secreted proteins that
mediate bacterial
attachment to intestinal
cells

Potter et al. 2004. *Vaccine* 22:362-369



Courtesy Dr. Brett Finlay

Phase III (Large-scale) Vaccine Trial

This project was supported by the National Integrated Food Safety Initiative of the USDA Cooperative State Research, Education and Extension Service, grant number #2003-04266

Vaccine

- Prepared by Bioniche Life Sciences, Inc.

Objectives

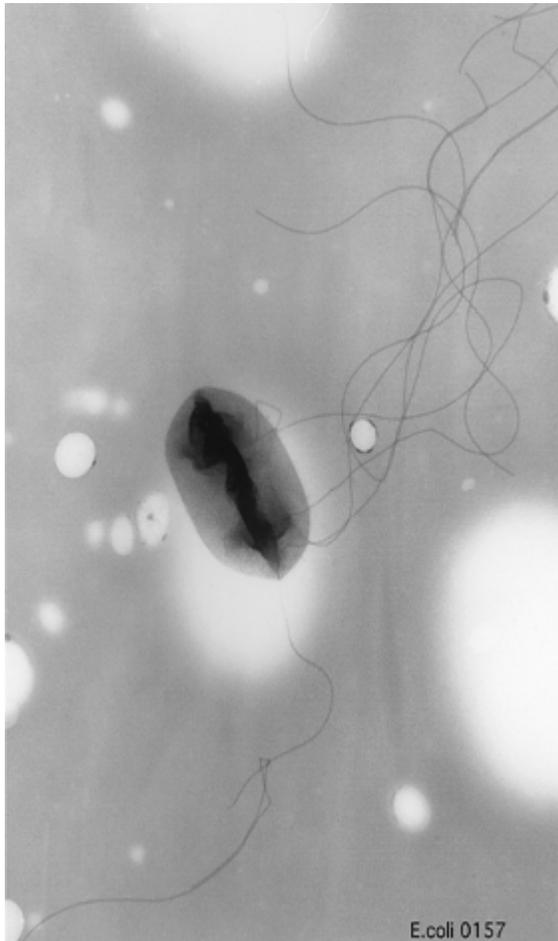
- Test vaccine efficacy in commercial feedyards
 - Treatments applied to pens of cattle

Outcome measures

- Culture of *E. coli* O157:H7
 - ROPES
 - Mucosal cells of the terminal rectum



E. coli O157:H7



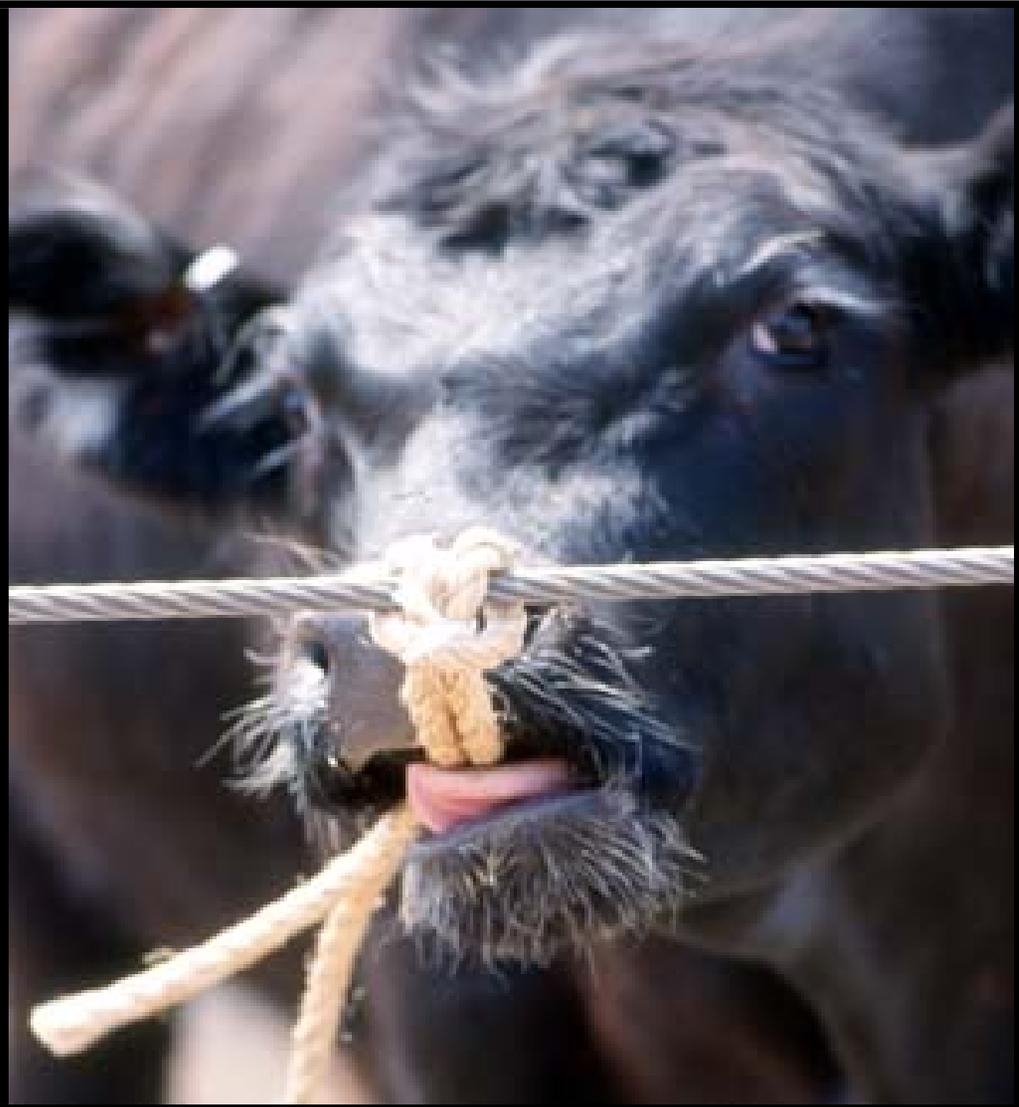
- selective enrichment
- O157 IMS
- CT/SMAC
- MUG-/MAC+
- latex aggl. O157
- PCR confirmation
 - *sxt*₁, *sxt*₂, *eae*_{O157}
 - *rfbE*_{O157:H7}
 - *fliC*_{h7}



ROPES

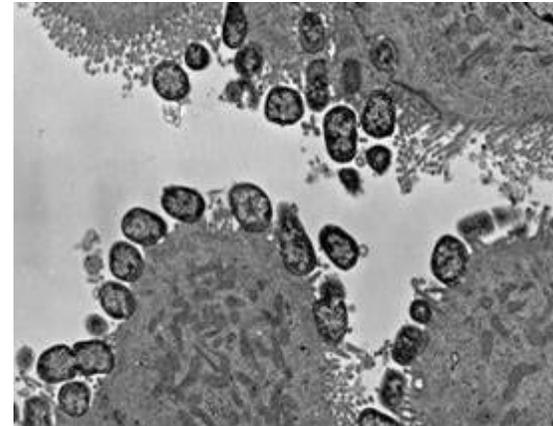


Smith et al. 2004. *Epid Infect* 132:297-302



Rectoanal junction mucosal cells

To identify cattle colonized with *Escherichia coli* O157:H7



- Aseptic technique
- Mucosa of the terminal rectum 3-5 cm proximal to the rectoanal juncture was scraped using a glass microscope slide
- Approximately 1.5 grams of rectoanal mucosa was placed in transport media and returned to the laboratory for bacterial culture.



Phase III (Large-scale) Vaccine Trial

- 19 commercial Nebraska feedyards
 - 2 doses of vaccine administered subcutaneously in the neck
 - Processing and reprocessing
 - Treated and untreated pens of cattle were randomized within the feedyard
 - Treated and untreated pens pair-matched on re-processing date
- ROPES as outcome measure
 - 4 test periods for each pen
 - 21 day intervals
- TRM colonization
 - Subset of cattle at harvest
- Initiated Feb 16, 2004
and completed Oct 31, 2004



Results

20,556 cattle, 140 pens, 19 commercial feedyards

Mean number of cattle per pen = 146.8 (range = 53-300)

- 86 pair-matched pens in feedyards feeding DFM
- 54 pair-matched pens in feedyards not feeding DFM

485 pen ROPES observations

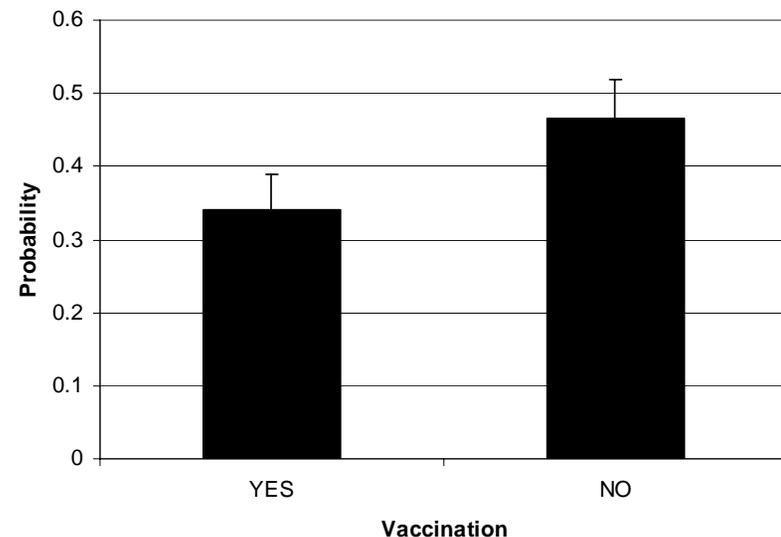
242 ROPES-positive (50%)



Results

Factors explaining the probability for pens to culture ROPES-positive

- **Vaccinated pens of cattle were less likely to be ROPES-positive (OR=0.59, $p=0.004$)**
- Other fixed effects
 - Month ($p=0.001$)
 - Region ($p=0.0001$)
 - Pen size ($p=0.009$)
 - Pen condition ($p=0.07$)
 - **No interaction of test period and treatment**



TRM Colonization Sampling strategy

- Pens of cattle were selected by convenience from the 140 pens in the larger trial (ROPES)
 - Logistics of following the cattle to processor
 - Blind to previous culture results



- The sample of cattle to test from a pen was calculated for the number of cattle within each pen.
 - 95% confident to estimate *E. coli* O157:H7 prevalence at 50% with 15% precision
 - Systematic selection

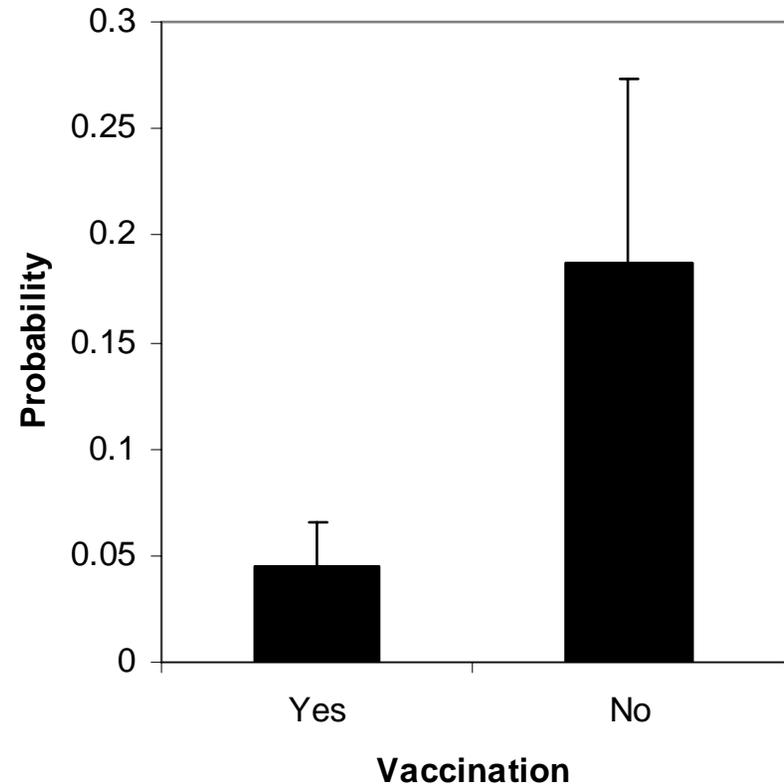
Results

- 720 cattle tested from 21 pens within 8 feedyards
 - 11 pens vaccinated, 10 pens not-vaccinated
 - 13 pens fed DFM, 8 pens not fed DFM
 - Mean number of cattle/pen = 175.4 (56-289)
 - Mean sample/pen = 34.3 (25-38)
- In total, 82 of 720 samples (11.4%) tested positive for *E. coli* O157:H7
- Variables tested to explain culture-positive results:
 - Vaccination
 - Feeding DFM (Bovamine)
 - Region
 - Month of harvest
 - Gender
 - Number of cattle in the pen
 - Days from vaccination to revaccination
 - Days from revaccination to harvest
 - Interaction of vaccination and DFM

Results: TRM colonization

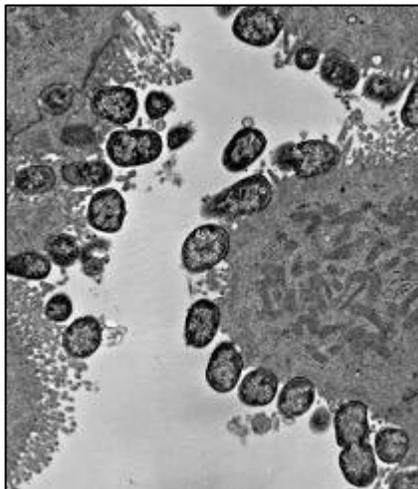
Factors explaining the probability for mucosal cells to culture positive for *E. coli* O157:H7 at slaughter:

- *E. coli* O157:H7 was less likely to be cultured from the mucosal cells of vaccinated cattle (OR=0.2, $p=0.03$)
- Vaccine efficacy = 76% within feedyard



Conclusion

Vaccination reduced the probability for colonization of cattle (TRM) and environmental detection of *E. coli* O157:H7 (ROPES) in commercial cattle feeding systems



This project was supported by the National Integrated Food Safety Initiative of the USDA Cooperative State Research, Education and Extension Service, grant number #2003-04266



Summary of UNL vaccine efficacy studies 2002-2005

Year	# of cattle	regimen	Outcome	Odds ratio	Vaccine efficacy	P-value	Comments
2002	192	3-dose	Feces	0.36	59%	0.04	"bench-top" vaccine
2003	608	1-dose	Feces	0.25	68%	0.0001	
		2-dose	Feces	0.26	67%	0.0001	
		3-dose	Feces	0.20	73%	0.0001	
		0-dose	Feces	0.36	59%	0.0003	herd immunity?
2003	1003	3-dose	RAMS	0.67	NS	>0.10	ranch vaccination, low prevalence
			Feces	0.81	NS	>0.10	
2004	288	3-dose	TRM	0.014	98%	0.0001	
			Feces	0.81	NS	0.56	low prevalence
2004	20,556	2-dose	TRM	0.20	75%	0.03	720 cattle
			ROPES	0.59	27%	0.004	19 NE feedlots
2005a	504	2-dose	Feces	0.35	62%	0.002	Between pens
			TRM	0.71	NS	0.65	
			Hides	0.45	54%	0.005	
2005b	168	2-dose	Feces	0.40	58%	0.005	Within pens
			TRM	0.73	NS	0.48	
			Hides	0.70	28%	0.06	

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 - ISVEE
 - VTEC
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 - Producers
 - State/National
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Veterinary Extension: Browse by Topic - Food Safety - Netscape

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http://vetext.unl.edu/byTopic/ttfoodsafety.sf

Veterinary Extension

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Timely Topic Archive

Food Safety

Vaccine, Feed Additive Work on E.Coli
A new vaccine and a beneficial bacterial feed additive each significantly reduced E.coli O157:H7 in feedlot cattle, according to University of Nebraska research.
Author: Dr. Rick Rasby, Professor of Animal Science
Date published: Mar-09-04

Beef Industry Leaders Encouraged By Significant Reduction in E. coli Incidence
Beef industry leaders today welcomed news from the Centers for Disease Control and Prevention (CDC) that the overall incidence of E. coli O157:H7 illnesses declined 36 percent in 2003.
Author: Dr. Rick Rasby, Professor of Animal Science
Date published: Apr-30-04

Bovine TB confirmed in a Minnesota wild deer
A wild deer killed in Roseau County, MN has tested positive for bovine tuberculosis. tests are still being conducted and the specific strain of bovine TB will be identified by the end of the month. (from a Jan 16, 2006 AP news story)
Author: Dr. David Smith, Associate Professor
Date published: Jan-17-06

Nebraska Beef Feedlot Roundtable Offered at Three Locations
LINCOLN, Neb. -- Nebraska feedlot owners and operators will learn more about animal health and cattle trade at the 2006 Beef Feedlot Roundtable. The roundtable will be offered at three locations this year -- Feb. 7 in Columbus, Feb. 8 in Lexington and Feb. 9 in Gering. Registration begins at 8:15 a.m., and the program begins at 8:45 a.m.
Author: Dr. David Smith, Associate Professor
Date published: Jan-17-06

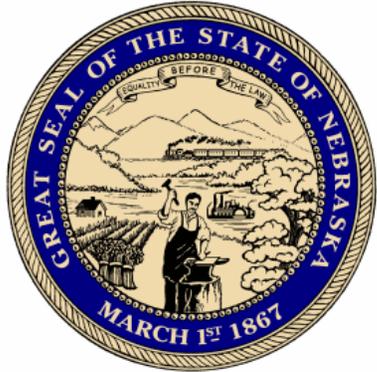
The prudent use of antibiotics: an important food safety issue
Recently I spoke at a public health conference where the topic was the presence of multidrug-resistant Salmonella in ground beef and the concern that these organisms originate on the farm. The topic is important. The appropriateness of using antibiotics in agriculture was questioned. Antibiotics are important for animal health and productivity. You, the animal caregiver, make important decisions about how antibiotics are finally used in food producing animals. Antibiotics should be used prudently to ensure they are effective, do not leave residues in food, and will continue to benefit man and animals in the future.
Author: Dr. David Smith, Associate Professor

Food Safety and Cattle Production
It used to be that if cattle producers thought about pathogens it was about how to control the agents that made their cattle sick. Today the issues confronting cattle producers are more often about assuring consumers about the quality and safety of beef.

Acknowledgments

Technical Staff

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- Chad Rolfes
- Angie Schleuter
- Nancy VanAckeren
- Mikayla Ward
- Travis Wolf
- Spring Younts



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